Hydrothermal Systems in Europa's Seafloor

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Hydrothermal systems on Earth are not well explored or understood. Latent heat of hydration in Europa's rocky crust was probably a source of energy in the young moon. Might serpentinization (conversion of peridotite to serpentine) of Europa's seafloor still be happening today?

Lowell and Rona (2002) estimated the age of the Lost City system, the first discovered in which serpentinization is the dominant energy source, based in part on a study by MacDonald and Fyfe (1970). Their model takes flow rate into account, and predicts an age of ~10^2 to 10^4 years, bracketing the ~30,000 year age inferred by Früh-Green *et al* (2003) by ^{14}C dating. In their analysis, Früh-Green *et al* suggest lower flow rate in other systems could extend their lifetimes to millions of years. Assuming fluid flow is low but sufficient to drive reaction, applying MacDonald and Fyfe's peridotite permeability data in the range of 34-100ºC suggests even longer time scales, O(100) million years for the 100ºC measurement, to completely alter 1 km of rock. Furthermore, Europa's seafloor pressure gradient is shallower than Earth's by a factor of 0.153, implying that hydration reactions could propagate to 6.5 times greater depth. Does greater propagation depth imply greater heat production at an earlier time, or persistence of aqueous alteration to the present time?

We consider how seafloor and sub-seafloor permeability, and mantle oxidation state affect reaction type, rate, and depth, The implications for aphotic life are explored at and under the seafloor, and in the overlying ocean.